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INDUSTRIAL WASTE SURVEY REPORT

Environmental Health Center
Cincinnati, Ohio

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INDUSTRIAL WASTE SURVEY REPORT

Detroit Sulphite Pulp and Paper Company
Detroit, Michigan

May 11 to May 14, 1953

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Center
Cincinnati, Ohio

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TABLE OF CONTENTS

General Information	1
Manufacturing Process	2
Fresh Water Uses	5
Waste Sources	5
Waste Reduction Measures	5
Survey Procedures	6
Explanation of Analyses	7
Discussion of Results	10
Summary	13

FIGURES

Figure 1. Flow Diagram	15

TABLES

Table I. Concentrations of Waste Constituents	16
Table II. Quantities of Waste Constituents	18

I. GENERAL INFORMATION

1. Organization of Survey

This survey was a cooperative study conducted by the Detroit Sulphite Pulp and Paper Company, Detroit, Michigan, the Michigan Water Resources Commission, and the Environmental Health Center of the Public Health Service.

Analytical determinations were performed by Public Health Service chemists in a mobile laboratory located on the property of the Wayne County Sewage Treatment Plant at Wyandotte, Michigan. Personnel of the Detroit Sulphite Pulp and Paper Company aided the field survey staff in becoming familiar with the liquid wastes sources, assisted in obtaining hydraulic data, and supplied pertinent plant data.

2. Dates of Survey

May 11 through May 14, 1953.

3. Purpose of Survey

This survey was conducted to determine the characteristics of the process wastes discharged from the plant to the Zug channel of the Detroit River. This project was a part of the continuing study of boundary waters pollution being conducted for the International Joint Commission.

4. Personnel Participating

Detroit Sulphite Pulp and Paper Company
- R. L. Davis, General Superintendent
- R. Moreseth, Chemical Engineer
- F. Tweddle, Chemist

Public Health Service
- D. M. Taylor, Public Health Engineer
- S. Soneda, Asst. Sanitary Engineer
- C. Shadix, Chemist
- S. Pinkoski, Chemist
- C. Hirth, Chemist
- P. Jones, Engineering Aid
- M. D. Currey, Laboratory Asst.

5. Location of Plant

The plant is located at 9125 W. Jefferson Ave., Detroit 17, Michigan, on the bank of the Zug Channel of the Detroit River.

6. Raw Materials

The principal raw material is wood. Approximately 200 cords of spruce are processed per day. Practically all of the wood used here is slow-growth northern spruce. Additional raw materials include sulphur, limestone, chlorine, filler, size and coloring materials.

7. Production

This plant produces approximately 125 tons per day of high grade paper. The finishing department turns out the paper according to customer specifications.

8. Operations

The plant operates 24 hours per day, 5 days per week.

9. Employees

The average number of employees is approximately 500.

10. Water Supply

Detroit city water is used for sanitary purposes. All other water is obtained from the Zug Channel of the Detroit River. It is treated with chemicals, filtered through rapid sand filters, and chlorinated for slime control. Boiler feed water is softened by the lime-soda process. Water consumption is 25-30 M.G.D.

11. Sewers

There are four outfall sewers from this plant designated as: filter wash water discharge line, bark sewer, power house sewer and pulp and paper mill sewer. The power house sewer discharges directly to the Zug Channel of the Detroit River, while the other three discharge into a small lagoon whose overflow empties into the same channel.

12. Sanitary Wastes

Part of the sanitary sewage is discharged to the Detroit municipal sewers. The remainder discharges directly to plant sewers, and thence to the Zug Channel of the Detroit River.

II. MANUFACTURING PROCESS

This is an integrated paper mill. Wood pulp is made from northern spruce cordwood by the sulphite (Mitscherlich) process. About 75 per cent of the pulp is bleached. High grade paper is made on Fourdrinier machines and finished according to customer specifications. The process flow is shown in Figure 1.

13. Pulp Mill

A. Preparation of Wood for Cooking

Logs, delivered to the plant, have already been cut to proper length. Two tumbling drums (12X45 ft.) are employed to de-bark and wash the logs. The pulpwood logs are then sorted so that residual bark may be cut off and

objectionable knots drilled out. They are then passed through a ten-knife chipper, after which the resulting chips are screened to uniform size and stored in hoppers above the digesters.

B. Acid Preparation

Calcium bisulphite solution is used to cook the wood chips and separate the cellulose fibers from the rest of the wood constituents. The cooking acid is made in a conventional Jensen 2-tower system. Sulphur is burned to form sulphur dioxide gas which is cooled and blown into a tower filled with limestone, over which water trickles. Sulphurous acid is formed which dissolves the limestone and produces calcium bisulphite solution.

C. Cooking Process

The Mitscherlich (indirect) cooking process is employed, which is characterized by the use of relatively low temperature (120-130°C), low pressure (80 lb. / sq. in.), long digestion time (16 hrs.), the use of heating coils instead of direct steam, and dumping of the digesters instead of blowing under pressure. Eight horizontal digesters are used, each one capable of cooking 18 cords of wood to produce 11 tons of pulp.

When cooking is completed, the pressure is released and the liquor allowed to drain through fine screens, in the outlets, to the sewer. Water is sprayed into the top of the digester during the draining period until the cooking liquor has been washed out of the pulp. The digester is finally filled with water, the outlet screens removed and the entire contents dumped into a drain pit where the final wash water is allowed to drain from the pulp.

D. Screening

The fibers, diluted with large volumes of water, are then passed through fine chromeplated screens to remove incompletely defibered wood, knots, and bark particles. The clean stock is dewatered by means of decker-type washers to form slush stock.

E. Bleaching

About 75 percent of the pulp is bleached by circulating the slush stock with chlorinated lime water in a single stage process. The coloring matter is destroyed or solubilized causing the pulp to appear snow white in color.

The bleached pulp suspension is filtered on rotary, vacuum filters and washed. the resulting slush pulp is then passed to the beaters or wet machines

F. Wet Machines

When pulp is to be shipped or stored. the bleached or unbleached slush pulp is drained and pressed into thick sheets called wet laps. Only about 5 per cent of the pulp was being wet lapped at the time of the survey.

14. Paper Mill

A. Beaters

Pulp stock is first prepared for paper formation by a process called "beating". Slush stock and wet laps are fed into a tank having rounded ends and a partition part way down the middle, thus giving a channel around which the pulp circulates contiruously. Fibers are pounded beneath paddle wheels running against rough plates. Beating frays and gelatinizes fibre surfaces, profoundly affects paper properties, causing higher density and tensile strength, lower opacity, lower absorptivity, etc. Rosin size, alum, aniline dyes, clays, starch, etc. are added in the beaters.

B. Refiners

From beaters, stock goes through Jordan engines to complete the refining. These machines are essentially conical shells, on the inside of which are set stationary bars. Revolving inside the shell is a core also set with bars. It is the action between these two sets of bars that produces the desired effect on the pulp.

C. Paper Sheet Forming

Refined paper stock is diluted and screened again before being sent to Fourdrinier type paper machines. The dilute stock (about 1/2 per cent fiber) flows from a head box through a sluice onto a moving, endless, bronze-wire screen. The pulp fibers remain on the screen while a great portion of the water drains through. As the screen moves along, it has a sidewise shaking motion which serves to orient some of the fibers and give better felting action and more strength to the sheet. While still on the screen, the paper passes over suction boxes to remove water and under a dandy roll which smooths the top of the sheet.

From the wire, the paper is transferred to the first felt blanket which carries it through a series of press rolls where more water is removed. Leaving the first felt, the paper passes through steel smoothing rolls and is picked up by the second felt which carries it through a series of drying rolls heated internally by steam. Sizing may be sprayed on the sheet at this point in which case it must pass through another series of drying rolls before entering the calender stack which is a series of smooth, heavy steel rolls which impart the final surface to the paper. Finished paper is wound on reels.

This paper mill is equipped with 6 Fourdrinier type paper machines. Three machines are of the Yankee type with single large drying rolls. The other three are combination Yankee Fourdrinier machines with a combination of small drying rolls and a single large Yankee roll for each machine.

The great quantity of water used makes it necessary to recirculate as much of it as possible for economical operation. Each machine is equipped with a saveall, five of which are of the Bird type and one of the sedimentation type. Recovered pulp is returned to paper stock make-up and

approximately 50 per cent of the white water is reused for beater make-up and diluting pulp stock.

III. FRESH WATER USES

The principal fresh water uses are as follows:

Pulp Mill

1. Debarkers and chippers.
2. Preparation of bisulphite liquor.
3. Washing of pulp in digesters.
4. Washing of pulp in screen room.
5. Preparation of bleach liquor.
6. Washing of bleached pulp.

Paper Mill

1. Beaters.
2. Mixing boxes.
3. Head box sprays.
4. Wire and felt showers on paper machines.

IV. WASTE SOURCES

The principal waste sources are as follows:

Pulp Mill

1. Wash water from debarkers and chippers.
2. Spent digester liquor and wash water from digesters.
3. Wash water from screen room.
4. Waste bleach solution and wash water from bleaching operations.
5. Waste water from wet machine.

Paper Mill

1. Wire pit water from paper machines.
2. Couch pit water from wire and felt showers, and from press rolls.

V. WASTE REDUCTION MEASURES

The principal measures employed to reduce quantities of waste constituents released in plant effluents are as follows:

1. Screens in debarking and chipping rooms which remove bark and chips from wash water. This material is burned in boilers.

2. Savealls and decker-type washers in the pulp mill screen room which remove fiber from white water. Recovered fiber is returned to the pulp stock line and some water is re-used on screens.

3. Re-use of wire and couch pit white water for beater make-up and dilution of furnish in mixing boxes.

4. Savealls on paper machine effluents which recover fiber from white water. Fiber is returned to the mixing boxes ahead of the paper machines, while the white water is partially re-used for showers on the paper machines.

VI. SURVEY PROCEDURES

15. Sample Collection

Plant operations were continuous (24 hours per day) for 5 days per week. Samples were composited manually in 1 gal. glass bottles, at 30 minute intervals, over 8-hour periods, from 8:00 A.M. to 4:00 P.M.

The characteristics of the pulp mill effluent vary regularly over approximately 2 hour intervals. A digester is dumped every 2 hours and it takes about 2 hours to wash and drain the pulp. Several grab and continuously composited samples of pulp mill effluent were taken to study the variables involved.

Samples were taken at the following points during the period of the survey:

(1) Raw water intake - Zug channel, Detroit River.

(2) Pulp mill effluent

(3) Paper mill effluent

(4) Combined pulp and paper mill effluents

(5) Bark sewer effluent

(6) Settling pond effluent (bark sewer effluent + combined pulp and paper mill effluents + water treatment plant effluent).

The raw water was sampled for the purpose of obtaining net values for quantities of waste constituents discharged from plant operations.

Sampling stations are shown in Figure 1.

16. Flow Measurements

Flows in the pulp mill sewer, paper mill sewer, combined pulp and paper mill sewer, and bark sewer were measured periodically over the period of the survey with a current meter. Average values were used at each point, rather than daily individual values.

The flow in the pulp will sewer fluctuated considerable due to the nature of pulp washing operations. A suppressed, rectangular weir was installed in the sewer and flow observed over a 15 hour period, using a level recorder. Average flow was 0.5 MGD.

The settling pond effluent was computed as the sum of the two main flows entering it, namely: pulp and paper mill effluent and bark sewer effluent. The water treatment plant effluent was considered to be relatively insignificant.

17. Laboratory Analyses

The following laboratory determinations were made on samples:

(1) Total solids

(2) Total volatile matter

(3) Suspended solids

(4) Suspended volatile matter

(5) B.O.D. - 5 day at 20° C

(6) pH

(7) Settleable solids - weight of solids settling out in 2 hours

(8) Settleable volatile matter

(9) Acidity - pulp mill effluent

The procedures followed in making the determinations were according to those given in "Standard Methods for the Examination of Water and Sewage", 9th Edition, with the exception of the settleable solids and settleable volatile matter. These latter determinations were empirical and designed to show results obtainable by 2 hours of settling. They were made by allowing samples to settle for 2 hours in glass cylinders and then running suspended solids and suspended volatile matter determinations on the supernatants.

VII. EXPLANATION OF ANALYSES

A brief explanation of the laboratory determinations is given below as an aid in the interpretation of the analytical results reported.

18. B. O. D.

The biochemical oxygen demand of sewage, polluted waters, or industrial wastes, is the oxygen (in ppm) required during stabilization of the decomposable organic matter by aerobic bacterial action. The rate of oxygen demand is dependent on both time and temperature and consequently the standard conditions of 5 days' incubation at 20°C are usually used for the test. Approximately 68 per cent of the oxygen demand of the carbonaceous material present in normal domestic sewage is satisfied under the conditions of 5 days' incubation at 20°C. The oxygen demand rates of industrial wastes, however, may or may not follow the typical oxidation curve for domestic sewage. It would be necessary to incubate a particular sample of waste for such a period of time that no more oxygen demand was exerted, in order to determine the total B.O.D.

High B.O.D. values are objectionable from a stream pollution standpoint because they reduce the oxygen resources of the streams, adversely affecting the aquatic life. If the oxygen content is depleted, anaerobic conditions develop and the water is rendered undesirable for supply and recreational purposes.

19. Solids

Suspended solids are insoluble solids which float on the surface of the liquid, remain in suspension, or settle out on standing. They are determined by filtering samples through asbestos mats in Gooch crucibles. Total solids consist of all the solids in a sample and include both suspended and dissolved solids. The settleable solids, determined in these studies, consisted of those settling out in a glass cylinder in two hours time. Volatile solids, or matter, are those solids in the sample which are lost on ignition at a temperature of 600°C for 15 minutes.

Suspended solids cause water to appear turbid and unsightly. Settleable suspended solids are objectionable because they cause silting and sludge banks. Suspended solids are particularly objectionable in water supplies used for domestic and industrial purposes. Relatively large amounts of dissolved solids may be objectionable in domestic water supplies for physiological reasons and in industrial water supplies for process reasons. The volatile solids (matter) results are obtained by an empirical method but they are intended to indicate the organic material content of the solids.

20. pH

The symbol "pH" denotes the negative logarithm of the hydrogen-ion normality. The pH value indicates the relative acidity or alkalinity of a solution, being lower with higher degrees of acidity.

pH data are helpful in measuring the effects of acid and alkaline wastes on natural surface waters. Acids causing pH values below 4.0 and alkalies causing pH values above 10.0 are undesirable and hazardous for fish life in waters which are not naturally so acid or alkaline. pH is also an important factor when considering treatment for domestic and industrial water supplies.

21. **Acidity**

The acidity of a water is usually caused by the presence of uncombined carbon dioxide, mineral acids, and salts of strong acids and weak bases. Industrial wastes may contain acid materials capable of producing hydrogen ions in solution. The amount of acidity is determined by titration with a standard solution of a strong base to a definite equivalence point as given by indicator solutions. Methyl orange indicator (pH approximately 4.0), or its equivalent, is used to obtain this equivalence point for "mineral acid" acidity. Phenolphthalein, or its equivalent (pH 8.1 to 8.2), is used to obtain the equivalence point for total acidity. Total acidity includes mineral acid acidity. Acidity results are expressed as ppm calcium carbonate.

The common strong mineral acids (H_2SO_4, H_2SO_3, HCl, and HNO_3) can be directly lethal to fish in most natural water when the pH is 5.0 or lower. A number of weak inorganic and organic acids can impart to some waters pronounced toxicity for fresh-water fish without lowering the pH to a value as low as 5.0. The toxicity under these conditions is attributable chiefly to the undissociated acid or acid gas in solution, or to the anions or salts of the acid involved. This latter group of acids includes sulfurous acid.

VIII. DISCUSSION OF RESULTS

The daily and average, gross and net, concentrations and quantities of waste constituents discharged from the Detroit Sulphite Pulp and Paper Company plant are shown in Table 1 and Table 2. There are four effluent sewers discharging to the Zug Channel of the Detroit River. The wastes from the power plant and water treatment plant are considered relatively insignificant. The wastes from the debarking and chipping sewer, and combined pulp and paper mill sewer are taken to represent the significant process wastes discharged from the plant.

22. Pulp Mill Effluent

The "pulp mill sewer" actually carries only the diluted spent digester liquor, i.e., spent digester liquor plus wash water used during the discharge of the liquor from the digesters. All the other liquid wastes resulting from pulping operations, including the liquid draining from the pulp in the "drain" or "blow" pits, flow to the "paper mill sewer".

Each digester is discharged over an approximately 2-hour period and both the concentrations of waste constituents and the flow of the pulp mill sewer effluent vary considerable.

The composite samples of the diluted spent digester liquor collected during this survey cannot be considered representative of the waste in question. In order that representative composite samples be collected, the sample increment should have been proportioned according to the flow at the time of collection.

The average flow in the pulp mill sewer was 0.5 MGD (or 347 gpm). The waste constituent values for the diluted spent digester liquor calculated by subtracting the paper mill effluent values from the combined pulp and paper mill effluent values are the best estimates that can be made for this segment of the plant wastes. The calculated values of the waste constituents of the diluted spent digester liquor are shown in Tables 1 and 2.

The dilute spent digester liquor is acid in character and have high BOD (approximately 19,000 ppm) and dissolved solids (approximately 84,000 ppm) contents. About 50 per cent of the dissolved solids are volatile at 600 °C. Suspended solids are relatively insignificant.

23. Paper Mill Effluent

The paper mill sewer carries not only all the liquid paper mill wastes but all the wastes from pulping, with the exception of digester liquor and wash water from the digesters. Such wastes as waste bleach liquor, screen room water, and wet machine effluent are included in the paper mill effluent. Consequently, all of the wastes discharged in the so-called paper mill effluent cannot be attributed to paper making operations.

Dissolved solids constitute about 88 per cent of the total solids. Due to the arrangement of sewers, most of the B.O.D. in the paper mill effluent is probably due to carry-over of dissolved organic matter from the pulp mill.

About 74 per cent of the suspended solids are volatile. If volatile suspended solids are taken to indicate fiber, then approximately 7.25 tons (net) of fiber are discharged daily from process operations discharging to the paper mill sewer. This is equivalent to 0.62 lb. per 1000 gal. waste, or 4.6 per cent fiber loss (based on 157 tons paper / day).

It is of interest to note that 70 per cent of the suspended solids will settle out in 2 hours under quiescent conditions. About 78 per cent of these settleable solids are volatile.

24. Bark Mill Effluent

Approximately 86 per cent of the solids contributed to plant wastes by debarking and chipping operations are suspended solids. About 76 per cent of these suspended solids are volatile, indicating that they are organic in nature. Eighty-seven per cent of the gross suspended solids are settleable in 2 hours, under quiescent conditions, 70 per cent of which are volatile at 600°C.

The average net unit quantities of waste constituents discharged in the debarking mill effluent are as follows:

Average Net Unit Quantities of Waste Constituents
Discharged From Barking and Chipping Mill

	Lbs. / Cord Wood Chips	Lbs. / Ton Pulp
B.O.D	7.6	12.
Total Solids	64.	100.
Total Volatile Matter	49.	76.
Suspended Solids	55.	86.
Suspended Volatile Matter	52.	81.
Flow - Gal / Ton Pulp	15,100	
" / Cord Chips	23,600	

25. Total Plant Effluent

Considering the wastes in the power plant effluent to be relatively insignificant, the process wastes discharged from the plant to the Zug Channel of the Detroit River are contained in the settling pond effluent. Neglecting the wastes from the water treatment plant, the concentrations and total quantities of waste constituents discharged to the settling pond may be computed by adding up the quantities discharged in the debarking and chipping, pulp, and paper mill sewers. They are shown in Tables 1 and 2.

The percentages of waste constituents contributed to the final settling pond by each process sewer effluent are as follows:

Waste Constituents Discharged to Final Settling Pond
Per Cent of Total

	Debarking and Chipping	Pulp	Paper
B.O.D.	2	77	21
Total Solids	3	64	33
Total Volatile Matter	3	62	35
Suspended Solids	35	2	63
Suspended Volatile Matter	34.5	0.5	65
Flow	11	2	87

When the calculated values of waste constituents in the settling pond influent are compared with the observed values for the effluent, it is noted that the only significant change occurs in the suspended solids results. Suspended solids are reduced 15 per cent and suspended volatile matter 21 per cent. Laboratory data showed that under quiescent conditions for 2 hours, 69 per cent of the suspended solids would settle out. Design and detention time limit the efficiency of the settling pond, especially in view of the fact that 63 per cent of the suspended solids are fines from the paper mill.

It is interesting to note that the acidity from the pulp mill was great enough on two sampling days to pull the pH of the final effluent below 7.0 (6.5 on the 13th and 5.8 on the 14th of May, 1953).

Pulp production was not in balance with paper production during the period of the survey so it is impossible to accurately express waste values in average net unit terms. On the basis of known paper production, the average net quantities of process waste constituents discharged from the plant, per ton paper, are as follows:

Average Net Unit Quantities of Waste Constituents
Discharged From Plant

	Lbs. / Ton Paper
B.O.D. - 5 day	643
Total Solids	3330
Total Volatile matter	1940
Suspended Solids	149
" Volatile Matter	125
Flow - Gal / Ton Paper	172,000

IX. SUMMARY

This plant produces high grade papers from wood pulp prepared in its own pulping mill.

The Mitscherlich sulphite cooking process is used to prepare wood pulp from northern spruce cordwood. Decker-type washers are employed in the screen room to form slush stock. About 75 per cent of the pulp stock is bleached in a single stock chlorination process. Approximately 5 per cent of the pulp was being wet lapped at the time of the survey.

Paper making involves the use of beaters, Jordans, mixing boxes, head boxes and Fourdrinier type paper machines. There are 6 Fourdrinier type paper machines: three being of the Yankee type; and the other three of the combination Yankee type.

Approximately 50 per cent of plant white water is reused. All paper machines are equipped with save-alls.

There are five sewers discharging water-carried waste from this plant namely: (1) power plant sewer, (2) water treatment plant sewer, (3) debarking and chipping mill sewer, (4) pulp mill sewer, and (5) paper mill sewer. Wastes from the power and water treatment plants are relatively insignificant. All sewers but the power plant sewer discharge into a small settling pond whose effluent flows into the Zug channel of the Detroit River.

All pulp mill wastes with the exception of digester wastes, flow into the paper mill sewer. Consequently, it is impossible to correctly differentiate between pulp and paper mill wastes.

Individual and total, average, daily, net quantities of waste constituents discharged from process operations are as follows:

Waste Constituent	Combined Pulp and Paper Mill Lbs. / Day	Debarking and Chipping Mill Lbs. / Day	Total Lbs. / Day
B.O.D. - 5 Day	100,000	1,500	102,000
Total Solids	483,000	12,700	496,000
Total VolatileMatter	286,000	9,600	296,000
Suspended Solids	18,200	10,900	29,100
Susp. VolatileMatter	14,600	10,300	24,900
Flow - MGD	24	3.	27

The only significant waste reduction occurring in the settling pond was in suspended solids. Suspended solids were reduced 15 per cent and suspended volatile matter 21 per cent.

Pulp mill production during the period of the survey was 127 tons / day, while paper production was 157 tons / day. Consequently waste values cannot be expressed strictly in accordance with production. On the basis of 157 tons of paper per day, average net unit quantities of waste constituents discharged from the plant per ton paper produced are as follows:

Waste Constituent	Lbs. / Ton Paper
B.O.D. - 5 day	647
Total Solids	3330
Total Volatile Matter	1940
Suspended Solids	149
Suspended Volatile Matter	125
Flow - Gal. / Ton Paper	172,000

Considering suspended volatile matter to be fiber, fiber loss in the paper mill sewer is 7.25 tons per day. This value includes screening and bleaching losses from the pulp mill but, nevertheless, probably represents fiber losses. On the basis of paper mill production total fiber loss is 0.62 pounds per thousand gallons waste, or 4.6 per cent.

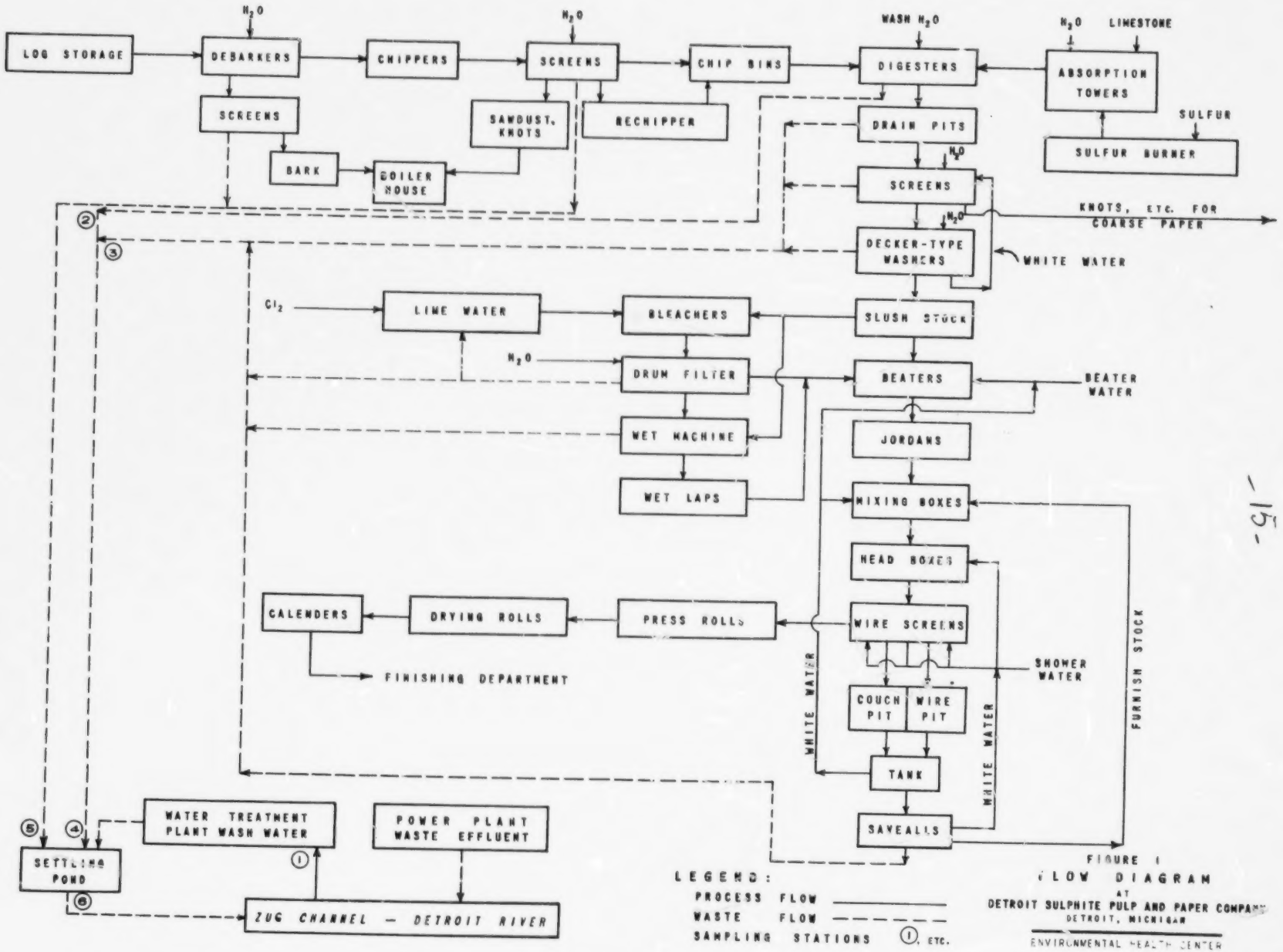

FIGURE 1

FLOW DIAGRAM

AT

DETROIT SULPHITE PULP AND PAPER COMPANY

DETROIT, MICHIGAN

ENVIRONMENTAL HEALTH CENTER

Environmental Health Center
Public Health Service
Cincinnati, Ohio

TABLE 1

Daily, Gross and Net, Concentrations of Waste Conn
Detroit Sulphite Pulp and Paper Company, Detro

Date 1953	BOD		Total Solids		Total Volatile Matter		Suspended Solids		Suspended Volatile Matter		Settleable Solids	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
	ppm		ppm		ppm		ppm		ppm		ppm	
Raw Water - 8 hour composite												
May 11	5.5		130		15		15		6		8	
12	2.2		150		42		16		7		7	
13	1.8		160		43		21		7		11	
14	4.0		140		23		26		8		19	
Avg.	4.4		145		31		20		7		11	
Paper Mill Effluent - 8 hour composite (every 30 min.)												
May 11	110	104	940	808	578	563	100	85	73	67	84	76
12	100	98	832	682	452	410	146	130	121	114	100	93
13	84	82	888	728	538	495	110	89	74	67	62	51
14	147	143	890	754	554	531	84	58	56	48	62	43
Avg.	110	107	888	743	531	500	110	90	81	74	77	66
Diluted Spent Digester Liquor - 8 hour composite (every 30 min.)												
May 11	7370	7360	40800	40700	19200	19200	34	19	32	19	20	12
12	8920	8920	42900	42800	20800	20800	18	2	18	2	9	2
13	5410	5410	34500	34300	13600	13600	34	13	32	13	12	1
14	11100	11100	42400	42300	23200	23200	32	6	28	6	20	1
Avg.	8200	8200	40200	40000	19200	19200	30	10	28	10	15	4
2 hour composite - 1 cycle												
May 22	12700	12700	47600	47500	28400	28400	34	14	27	14	15	4
Grab Sample - Apparent Maximum Concentration												
May 22	24700	24700	84000	83900	55400	55400	45	25	34	25	26	15
Calculated Values (Combined Pulp & Paper Mill Effluent Minus Pa												
Avg.	19000	19000	81200	81100	45000	45000	160	140	32	25	-	-

TABLE 1

Daily, Gross and Net, Concentrations of Waste Constituents - ppm
Detroit Sulphite Pulp and Paper Company, Detroit, Michigan

tal latile tter		Suspended Solids		Suspended Volatile Matter		Settleable Solids		Settleable Volatile Matter			Acidity			
ss	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	pH	Total Gross	Total Net	Mineral Gross	Mineral Net
ppm		ppm		ppm		ppm		ppm			ppm		ppm	
3		15		6		8		2		8.0				
2		16		7		7		3		7.8				
3		21		7		11		2		8.0				
3		26		8		19		4		8.5				
1		20		7		11		3						
r 30 min.)														
3	563	100	85	73	67	84	76	63	61	7.9				
2	410	146	130	121	114	100	93	94	91	7.0				
8	495	110	89	74	67	62	51	44	42	7.2				
4	531	84	58	56	48	62	43	40	36	7.1				
1	500	110	90	81	74	77	66	60	57					
ite (every 30 min.)														
0	19200	34	19	32	19	20	12	17	12	3.1	1440	1440	231	231
0	20800	18	2	18	2	9	2	9	2	3.0	1850	1850	352	352
0	13600	34	13	32	13	12	1	11	1	3.5	959	959	52	52
0	23200	32	6	28	6	20	1	15	1	3.6	2280	2280	514	514
0	19200	30	10	28	10	15	4	13	4		1630	1630	287	287
e - 1 cycle														
0	28400	34	14	27	14	15	4	11	4					
pparent Maximum Concentration														
0	55400	45	25	34	25	26	15	17	14					
es (Combined Pulp & Paper Mill Effluent Minus Paper Mill Effluent)														
0	45000	160	140	32	25	-	-	-	-					

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TABLE 1 (Cont'd - 2)

Environmental Health Center
Public Health Service
Cincinnati, Ohio

Daily, Gross and Net, Concentrations of Waste Const
Detroit Sulphite Pulp and Paper Company, Detroit

Date 1953	BOD		Total Solids		Total Volatile Matter		Suspended Solids		Suspended Volatile Matter		Settleable Solids	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
	ppm		ppm		ppm		ppm		ppm		ppm	
Combined Effluent from Pulp and Paper Mills - 8 hr. composite (every 30 m												
May 11	507	501	2710	2580	1540	1520	119	104	78	72	78	72
12	602	600	2990	2840	1760	1720	114	98	83	76	68	61
13	313	311	2000	1840	1010	965	132	111	91	84	76	65
14	590	586	2550	2410	1540	1520	79	53	68	53	51	32
Avg.	503	500	2560	2415	1460	1430	111	91	80	71	68	58
Bark Sewer Effluent - 8 hr. composite (every 30 min.)												
May 11	46	40	544	412	363	348	396	381	291	285	354	346
12	22	20	276	126	114	72	50	34	28	21	29	22
13	54	52	644	484	428	385	338	317	272	265	267	256
14	130	126	1150	1010	754	731	1120	1010	766	758	1000	981
Avg.	63	60	654	508	415	384	476	436	339	332	412	401
Settling Pond Effluent - 8 hr. composite (every 30 min.)												
May 12	563	561	2800	2650	1630	1590	113	97	83	76	67	60
13	241	239	1880	1720	814	771	101	80	66	59	54	43
14	557	553	2740	2600	1710	1690	160	134	132	126	128	109
Avg.	454	451	2470	2320	1380	1350	125	104	94	87	83	71
Settling Pond Influent - Calculated Values (Effluents from Pulp & Paper Mills plus Bark Mill)												
Avg.	456	452	2340	2200	1340	1310	151	131	109	102	107	96

TABLE 1 (Cont'd - 2)

ly, Gross and Net, Concentrations of Waste Constituents - ppm
etroit Sulphite Pulp and Paper Company, Detroit, Michigan

le	Suspended Solids		Suspended Volatile Matter		Settleable Solids		Settleable Volatile Matter			Acidity			
										Total		Mineral	
Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	pH	Gross	Net	Gross	Net
m	ppm		ppm		ppm		ppm			ppm		ppm	
p and Paper Mills - 8 hr. composite (every 30 min.)													
1520	119	104	78	72	78	72	55	53	5.6				
1720	114	98	83	76	68	61	58	55	8.2				
965	132	111	91	84	76	65	62	60	6.3				
1520	79	53	68	53	51	32	42	32	5.5				
1430	111	91	80	71	68	58	54	50					
r. composite (every 30 min.)													
348	396	381	291	285	354	346	255	253	7.2				
72	50	34	28	21	29	22	16	13	7.5				
385	338	317	272	265	267	256	211	209	7.2				
731	1120	1010	766	758	1000	981	668	664	7.3				
384	476	436	339	332	412	401	288	285					
hr. composite (every 30 min.)													
1590	113	97	83	76	67	60	56	53	8.0				
771	101	80	66	59	54	43	40	38	6.5				
1690	160	134	132	126	128	109	107	103	5.8				
1350	125	104	94	87	83	71	68	65					
ments from Pulp & Paper Mills plus Bark Mill)													
1310	151	131	109	102	107	96	80	77	-				

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Table 2

AVERAGE, GROSS AND NET, QUANTITIES OF WASTE CONSTITUENTS

POUNDS PER DAY

Environmental Health Center
Public Health Service
Cincinnati, Ohio

Flow MGD	BOD 5-Day 20°C. Lbs./Day		Total Solids Lbs./Day		Total Volatile Matter Lbs./Day		Suspended Solids Lbs./Day		Susp.Volatile Matter Lbs./Day		Settleable Solids Lbs./Day		Settleable Volatile Matter Lbs./Day	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Paper Mill Effluent														
23.5	21,600	21,000	174,000	146,000	104,000	98,000	21,600	17,600	15,900	14,500	15,100	12,900	11,800	11,200
Calculated Diluted Spent Digester Liquor														
0.5	79,400	79,000	338,000	337,000	188,000	188,000	670	590	130	100	-	-	-	-
Combined Effluent From Pulp and Paper Mills														
24.0	101,000	100,000	512,000	483,000	292,000	286,000	22,300	18,200	16,000	14,200	13,600	12,900	11,800	10,000
Bark Sewer														
3.0	1,580	1,500	16,400	12,700	10,400	9,600	11,900	10,900	8,490	10,300	10,000	10,000	7,210	7,140
Calculated Settling Pond Influent														
27.0	103,000	102,000	528,000	496,000	302,000	296,000	34,200	29,100	24,500	24,900	23,600	22,900	19,000	17,100
Settling Pond Effluent														
27.0	102,000	101,000	556,000	523,000	311,000	304,000	28,200	23,400	21,200	19,600	18,700	16,000	15,300	14,600